the Transvaal meteorological service. In no part of the world have the last few years seen a greater advance than in the Antarctic. In the second edition two pages sufficed to summarise our knowledge of its climate. In the present one twenty-two pages are assigned to it, in which we find, perhaps for the first time, a summary of all the data collected between the Ross expeditions of 1840 and Shackleton's dash for the pole.

Not the least valuable part of the book is provided by the very complete references to the sources from which information is taken or to works in which further details may be found. Many of these are to such recent publications that they can only have been added as the proof-sheets were going through the press. In such a complete work it seems almost ungrateful to ask for more, but we should have liked to see more maps included in the book. Ten diagrams seem a small allowance for 700 pages of letterpress in a subject which depends so largely on geographical distribution as climatology does. An atlas should always be at hand when the book is being consulted.

(2) It is instructive to turn from a book like the "Handbuch," which deals in the comparatively small space of 700 pages with the climate of the temperate and polar regions, to a work like that recently issued under the joint authorship of Maurer, R. Billwiller, jun., and C. Hess, on the climate of Switzerland. Two quarto volumes, together running to more than 500 pages, devoted to the climate of some 15,000 square miles of the earth's surface! We find ourselves asking what space would be required to deal equally fully with the whole area discussed by Hann. The authors have, however, had in view a totally different object. They have set themselves the task of summarising the observations which are available for their country in the year-books of the Swiss Meteorological Institute. They have followed to some extent the plan adopted in the somewhat similar publications for the provinces of Austria to which reference has been made above. Tables comprise a large part of the work. One set gives the average values for the meteorological elements usually observed at stations of the second order for ninety-five stations, based wherever possible on observations for the period 1864, the year of establishment of the Confederate meteorological service, to 1900. In the case of mean temperature normal values for the period 1864–1900 have been computed by extra-polation whenever the observations extended over a sufficiently long period to justify doing so. Another set of tables gives the monthly means for the principal elements for each year of the period for those stations which have been in operation throughout. There is thus plenty of material for the study of meteorological problems from the historical point of view. Average hourly values are also given for a few places for the most important elements. The whole forms a most valuable body of statistics.

The first volume of 300 pages is devoted to the discussion of the data. The plan adopted is a combination of that followed in France and Italy, where the distribution of one element over the whole country forms the subject of elaborate works, such as Angot's temperature tables, or Eredia's rainfall tables, and the Austrian method of considering the climate of each region as a whole. We have first a few chapters devoted to the consideration of the distribution of each element, and then a detailed discussion by regions. In the section on temperature, considerable space is devoted to the interdiurnal variability of temperature and to the frequency of changes of given magnitude. As at other places in Central Europe, the variability is smallest in September for most stations, but the mountain stations show a distinct minimum in April. The greatest variability occurs at moderate altitudes on the southern slopes of the Alps. In the section on rainfall we have a new map of the distribution of annual rainfall, based on observations at 400 stations, reduced to the forty-year period 1864–1903. The highest value is 251·4 cm. on the Säntis, at an altitude of 2500 m., the lowest 52·8 cm. at Grächen, in the Upper Rhone valley, at an altitude of 1629 m. We should have expected rather more information regarding the average depth of snow, but systematic observations thereon are of comparatively recent date. For a number of places it is possible to give the average earliest and latest dates on which snow remains lying. At stations at 1000 m. there are on the average 140 to 150 days in the year with snow lying, and during the winter months almost all days come into this category. Figures are also given for a selection of stations of the percentage of the total precipitation which falls as snow. The increase with height is approximately linear, being at the rate of 1 per cent. per 100 feet. Very interesting results are given for the records of bright sunshine on the mountain stations, for which the percentage of the possible shows a distinct maximum in winter. The Säntis records 49·3 per cent. of the possible during November, and 47·5 per cent. for December, the corresponding figure for June being 31·2 per cent. For Ben Nevis the percentages for these months are:—November, 11; December, 9; and June, 22. In an appendix Dr. Hess discusses the statistics of thunder and hailstorms, which have been collected systematically during the past twenty years.

We congratulate the authors and the Swiss Central Meteorological Institute on the completion of this most important contribution to the climatology of their country.

THE LAST VOLUME OF LORD KELVIN'S PAPERS.

Mathematical and Physical Papers. Vol vi., Voltaic Theory, Radio-activity, Electrons, Navigation and Tides, Miscellaneous. By the Right Hon. Sir William Thomson, Baron Kelvin, O.M., P.C., G.C.V.O. Arranged and revised, with brief annotations, by Sir Joseph Larmor, Sec.R.S. Pp. viii+378. (Cambridge: University Press, 1911.) Price 10*s.*

A FEW months ago we reviewed the fourth and fifth volumes of Lord Kelvin's "Mathematical and Physical Papers," and now we have the sixth and concluding volume. Sir Joseph Larmor is to be congratulated on the conclusion of a task which,

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however congenial to him, must have caused him a good deal of labour and anxiety. And the work has been done in the best possible way. The short notes appended here and there are very helpful, but the personality of the editor is never obtruded; indeed, it might sometimes, with advantage perhaps, have been more in evidence. The error, if it be one, is on the right side, and it may be that in connection with the selection of letters which we understand it is proposed to publish, we may have more of the editor's views on the various scientific questions, still unsettled, which are raised in these volumes.

The present volume contains papers on the electrification of air, on contact electricity, on radioactivity, on navigational and tidal instruments, terrestrial magnetism and the correction of the compass, and one or two of Lord Kelvin's last popular addresses. These papers are for the most part too recent for discussion here; the continued progress of research on ionisation and radio-activity is a commentary on many of them, and in any case we have no space for even a descriptive account of their content.

A word may perhaps be said on the vexed question of contact electromotive force between metals. Surely the reality of any contact difference of potentials must depend on whether or not any perceptible energy change—evolution or absorption—takes place at the surface, or rather the locality, of contact. When a part of a circuit carrying a current is moved in a magnetic field work is done upon or by that part, and energy is there absorbed or evolved, while in all parts of the circuit there is energy converted into heat with a corresponding potential gradient. And when there is change of potential from metal to liquid or from liquid to metal, or from liquid to liquid, energy changes which correspond are concerned. The process is, if anything, still more evident in thermo-electric circuits, and leads to an absolute evaluation of electromotive force. Now there must at bottom be unity of cause of electromotive force, and the existence of a finite contact electromotive force between metal and metal, which seems to have been insisted on to the last by Lord Kelvin, is, from the point of view of the energetics of the circuit, a great difficulty to some at least of those who are earnestly striving to obtain a clear and consistent view of voltaic phenomena.

The papers on radio-activity are very interesting as heroic attempts to explain on dynamical grounds, without calling into play any process of atomic disintegration, the extraordinary energy changes which radium and its products have disclosed. The comparison (p. 209) of the permanent rise of temperature of a thermometer which has radium near its bulb with the excess of temperature of a vessel containing black cloth over that of a similar vessel containing white cloth, when both vessels are immersed in baths of water exposed to the sun's rays, seems only to make the difficulty of any such explanation more evident, at least to the mind of the ordinary student. What corresponds to the sun's radiation in the radium experiment? According to this hypothesis, the radium "somehow" picks up energy of ethereal waves in a very special and effective manner. Is it not simpler and more reasonable to put down in the ordinary way the energy evolved to the changes effected in the stuff, especially as such changes are chemically manifest? It would seem so; and yet the suggestion must be received with respect and tested as far as possible, even though it appear to involve the reconsideration of many other cases of physical and chemical change.

The navigational and tidal papers are less sensational, but are of great interest in connection with terrestrial physics. The tide-predicting machine, set from the results of the analysis of tide curves, makes the past disclose the future in a very remarkable manner, and if nothing else had directly or indirectly come out of the work of the British Association Committee on Tides, would have justified the whole expenditure on that subject. But much more has come; through Lord Kelvin's and Sir George Darwin's guidance and the work of the committee and its skilled calculators the book of the tides of long period has been opened, and its secrets are being read.

As a lesson on the theory and practice of mechanical integration the tidal analyser ought to be better known than it is. We have not seen, except in connection with the tidal application, any adequate popular account of it; and yet the machine, from the point of view of integration-theory, and even of differential equations, is of great interest and importance. The machine with two complete harmonic components in periods of the ratio 1 : 2 is, or was, used for variations of atmospheric pressure; but the large machine constructed for the tidal application and described in the volume of papers before us stands inactive at South Kensington.

The oration on James Watt and the inaugural address delivered as chancellor of the University of Glasgow are given as interesting memorials of Lord Kelvin's lifelong association with Glasgow. They were reported in NATURE at the time, but their reproduction here gives a fitting personal note with which to close the long and brilliant record of scientific work which these volumes contain, a record which is one of the most glorious scientific facts of the most scientific age of the world's history.

A. G.

SEWAGE PURIFICATION.

Modern Methods of Sewage Purification: a Guide for the Designing and Maintenance of Sewage Purification Works. By G. Bertram Kershaw. Pp. xiii + 356. (London: Charles Griffin and Company, Ltd., 1911.) Price 21*s.* net.

IN view of the numerous text-books dealing with the purification of sewage which have recently appeared it would seem difficult to justify the publication of a further work on the subject. During the long period in which the author has been associated with the Royal Commission on Sewage Disposal he has had exceptional opportunities of personally investigating the various methods which have been adopted for the solution of the difficult problem of the economic disposal of sewage, and consequently he is well qualified to undertake a treatise on the subject.

The book to a very large extent, however, owes its justification to the systematic and exhaustive

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